PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
PHDE000004WO		
International application No. PCT/EP 00/09197	International filing date (day/month/year) 18/09/2000	(Earliest) Priority Date (day/month/year) 18/09/1999
Applicant KONINKLIJKE PHILIPS ELECTRONICS N.V.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

      [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

      [ ] contained in the international application in written form.
      [ ] filed together with the international application in computer readable form.
      [ ] furnished subsequently to this Authority in written form.
      [ ] furnished subsequently to this Authority in computer readble form.
      [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
      [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant.
   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.
   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 2

   [X] as suggested by the applicant.
   [ ] because the applicant failed to suggest a figure.
   [ ] because this figure better characterizes the invention.
   [ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 00/09197

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04B3/54

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04B H01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 621 170 A (PICANDET JEAN A) 4 November 1986 (1986-11-04) column 2, line 25 - line 40 column 5, line 10 - line 53	1-11
A	EP 0 520 680 A (AMERICAN TELEPHONE & TELEGRAPH) 30 December 1992 (1992-12-30) abstract	1-11
A	US 5 852 635 A (CRANE RONALD C) 22 December 1998 (1998-12-22) abstract	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 November 2000	07/12/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	De Iulis, M

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 00/09197

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		US 5614905 A	25-03-1997
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(81) Designated States *(national)*: CN, JP, KR, US.

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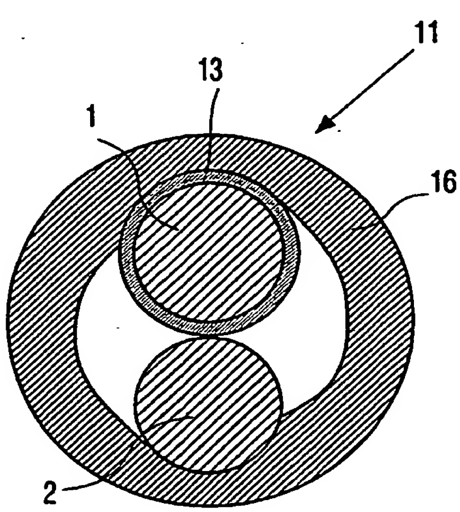
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: NETWORK CONNECTION



(57) Abstract: In a network connection comprising at least two wires (1, 2) for electrically connecting network users (3, 4, 5, 6, 7) in a network, joint data transmission and energy transfer from a terminal of a voltage source via the two wires of the network connection is ensured in that the network connection has a symmetrical structure and the two wires (1, 2) are twisted, in that the wires (1, 2) are mutually insulated to such an extent (13; 21, 22; 34; 35) that they are suitable for a symmetrical, differential data transmission, and in that the two wires (1, 2) have the same electrical resistance and jointly have a cross-section which is suitable for energy transfer from a terminal of a voltage source to network users (3, 4, 5, 6) via both wires (1, 2).

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The invention relates to a network connection comprising at least two wires for electrically connecting network users in a network.

Known network connections are constructed in such a way that they are suitable for data transmission through the two wires of the network connection. This has the drawback that both terminals of an energy power supply for the network users are to be realized via separate electric connections.

It is an object of the invention to provide a network connection which is suitable for both data transmission and energy transfer.

According to the invention, this object is solved in that the network connection has a symmetrical structure and the two wires are twisted, in that the wires are mutually insulated to such an extent that they are suitable for a symmetrical, differential data transmission, and in that the two wires have the same electrical resistance and jointly have a cross-section which is suitable for energy transfer from a terminal of a voltage source to network users via both wires.

In this network connection, data can be transmitted through the two wires. Moreover, the energy transfer can jointly take place through the two wires in that a terminal of a voltage source is coupled to the two wires so that energy transfer to the network users can take place through these wires.

For the energy transfer, the two wires jointly have such a cross-section that they are suitable for the currents flowing in response to the energy transfer.

The data transmission is advantageously realized symmetrically and differentially. To this end, the two wires are mutually insulated. This insulation should only be sufficient for the relatively low data transmission voltages. It should particularly not be suitable for relatively high voltages of a power supply for the network users, because only one pole of a voltage source is jointly coupled through the two wires.

Moreover, the two wires have the same electrical resistance in order that the symmetrical differential data transmission through the two wires has the same resistance. Moreover, the data transmission is thus not disturbed by the potential jumps which may occur as a result of the energy transfer.

The network connection has a symmetrical construction. This results in a high attenuation of disturbances of the power supply lines, which is achieved via a cancelling means ("Auslöschung").

To achieve a satisfactory decoupling with respect to external electric and magnetic fields, the two wires are advantageously twisted. This results in an improved mutual magnetic coupling of the two wires, which contributes to the signal-to-noise ratio of the data transmission.

Since the load current for the energy supply is jointly passed through the two wires of the network connection, it is not desirable to use additional copper for this purpose. The overall cross-section of the two wires must only be chosen to be as large as the cross-section of a wire of a separate cable connection for the energy transfer.

For the insulation between the two wires, a thin, inexpensive insulation is admissible because, on the one hand, only the low data transmission voltages are to be insulated and, on the other hand, only the communication rather than the energy supply drops out, even in the case of a failing insulation.

As described in an embodiment as defined in claim 2, only one of the wires may be provided with an insulation for this purpose.

Since the insulation can be formed in a relatively simple manner, a lacquer coating, a synthetic material coating or a tubing may be provided as insulations, as described in further embodiments of the invention.

When stranded wires are used, they can be advantageously insulated by means of a cladding of one of the stranded wires or by means of an insulation between the two stranded wires, as described in a further embodiment of the invention as defined in claim 6.

The network connection according to the invention may also be in a double form, as defined in claim 7. A pole for the energy supply is then coupled via one of the network connections. The data transmission may be realized in a redundant form through the two network connections so that the transmission reliability is enhanced.

To simplify a contact of the network connection, for example, to a network coupler, the outer insulation and the twisting of the wires may be advantageously formed as defined in claim 8.

The network connection according to the invention can be advantageously used in vehicles in which a pole for the power supply is coupled via the chassis of the vehicle. Then, both the data transmission and the power supply for the other pole can take

place via the network connection according to the invention. An additional cable connection with two wires for the power supply can then be dispensed with.

These and other aspects of the invention are apparent from and will be elucidated with reference to the embodiments described hereinafter.

In the drawings:

Fig. 1 shows a network comprising a plurality of network users, among which a network connection according to the invention is established,

Fig. 2 is a cross-section through a first embodiment of a network connection according to the invention, in which only one wire is insulated,

Fig. 3 is a cross-section through a second embodiment of a network connection according to the invention, in which both wires are provided with a thin lacquer coating, and

Fig. 4 is a cross-section through a third embodiment of a network connection according to the invention, in which the wires are formed as stranded wires.

Fig. 1 shows a network connection according to the invention, with two wires 1 and 2. The network connection has a star-shaped configuration and interconnects a plurality of network users 3, 4, 5 and 6. A further network user 7 is provided which is coupled to a terminal of a voltage source U_B and couples this terminal into the two wires 1 and 2 of the network connection.

Via network couplers 8, the network users 3, 4, 5 and 6 are capable of coupling out the required energy symmetrically from the two wires 1 and 2 of the network connection. Furthermore, the network users 3, 4, 5 and 6 transmit data via the two wires 1 and 2 of the network connection according to the invention, which is coupled in and coupled out via the network couplers and is formed in such a way that the data are transmitted symmetrically and differentially through the two wires 1 and 2.

The other terminal of the voltage source U_B may be connected, for example, to the chassis of the vehicle comprising the network users 3 to 7.

The circuit diagram shown in Fig. 1 illustrates that an additional cable connection with two wires for the transfer of energy may be dispensed with in the network connection according to the invention. One terminal for the power supply is coupled via the

two wires 1 and 2 of the network connection according to the invention, and the other terminal is coupled via the chassis of the vehicle.

Due to the specific construction of the two wires 1 and 2 of the network connection according to the invention, which will be further described hereinafter, these wires 1 and 2 are also simultaneously suitable for a symmetrical, differential data transmission.

This is particularly achieved in that the two wires 1 and 2 are symmetrical and the energy is transferred symmetrically through the two wires. Disturbances caused by the energy transfer thus do not affect the data transmission, because the differential, symmetrical transmission cancels the disturbances during the evaluation of the data transmission.

The two wires 1 and 2 are mutually twisted so as to achieve a satisfactory decoupling from external electric magnetic fields. Moreover, the magnetic coupling between the two wires is thereby improved.

The mutual insulation of the two wires may be relatively simple and thin because this insulation should only insulate the relatively low data transmission voltages. Since a pole for the power supply is jointly coupled through the two wires, these relatively high currents or voltages do not require insulations between the wires.

Fig. 2 is a cross-section through a first embodiment 11 of a network connection according to the invention, with two wires 1 and 2. The two wires have the same cross-section and are electrically constructed in such a way that they have the same resistance.

In the embodiment shown in Fig. 2, only one of the wires, namely the wire 1, is provided with a thin outer insulation 13. This insulation 13 may be, for example, an insulating tubing or a lacquer coating. This insulation 13 should only be formed in such a way that it is adequate for the opposite data transmission voltages occurring in the two wires 1 and 2, which voltages are, however, relatively small.

Furthermore, a joint outer insulation 16 is provided.

The two wires 1 and 2 are mutually twisted in a way which is not further shown in Fig. 2.

To make optically optimal connection points, for example, for network couplers or the like visible in the network connection, the outer insulation 16 may be advantageously formed in such a way that the position of the two wires 1 and 2 in the network connection is visible, i.e. the twisting is recognizable from the exterior. Moreover,

the twisting of the two wires may be advantageously interrupted so as to provide optimal connection points on the two wires 1 and 2.

The cross-section through the first embodiment of the network connection according to the invention, as shown in Fig. 2, illustrates that both a data transmission and a terminal for a voltage source can be established via a network connection which is actually built up in a relatively simple manner, in which even the mutual insulation of the wires may be relatively simple.

This is also shown by a second embodiment shown also in a cross-section in Fig. 3 of a network connection according to the invention which also comprises two wires 1 and 2. However, in the second embodiment shown in Fig. 3, both wires 1 and 2 are provided with a thin outer insulation 21 and 22, respectively. For example, a thin lacquer coating which can be provided in a relatively easy way is sufficient for this purpose. Basically, this insulation may also consist of a synthetic material coating. It is alternatively possible to slide, for example, thin tubings on one or both wires 1 and 2.

The complete network connection is surrounded by an outer insulation 21.

Fig. 4 also shows, in a cross-section, an embodiment of a network connection according to the invention, in which the two wires 1 and 2 are constituted by stranded wires 32 and 33.

In Fig. 4A, the stranded wires 32 and 33 are mutually separated and insulated by means of an insulation 34. The complete stranded wires 32 and 33 are embedded in an insulation 35 so that they cannot move with respect to each other, and the insulation 34 ensures a safe insulation of the two stranded wires 32 and 33 forming part of the two wires 1 and 2.

Fig. 4B is similar to Fig. 4A, showing wires 1 and 2 constituted by stranded wires 32 and 33. However, in this case, not only an insulation 34 as in Fig. 4A is provided but also a cladding for one of the stranded wires. In the embodiment shown in Fig. 4B, the stranded wires 33 of the second wire 2 are completely insulated from the exterior by this cladding 36. Here again, the two stranded wires 32 and 33 are embedded in an outer insulation 35.

All embodiments shown in the Figures show that the network connection according to the invention may have a relatively simple structure because only a simple insulation between the wires 1 and 2 is required. Nevertheless, it is suitable for data transmission as well as for energy transfer.

CLAIMS:

1. A network connection comprising at least two wires (1, 2) for electrically connecting network users (3, 4, 5, 6, 7) in a network, characterized in that the network connection has a symmetrical structure and the two wires (1, 2) are twisted, in that the wires (1, 2) are mutually insulated to such an extent (13; 21, 22; 34; 35) that they are suitable for a symmetrical, differential data transmission, and in that the two wires (1, 2) have the same electrical resistance and jointly have a cross-section which is suitable for energy transfer from a terminal of a voltage source to network users (3, 4, 5, 6) via both wires (1, 2).

2. A network connection as claimed in claim 1, characterized in that only one wire (1; 2) in the network connection is provided with an insulation (13; 21).

3. A network connection as claimed in claim 2, characterized in that only one of the wires (1; 2) in the network connection is provided with a lacquer coating (21) used as an insulation.

4. A network connection as claimed in claim 2, characterized in that only of the wires (1; 2) in the network connection is provided with a synthetic material coating (13) used as an insulation.

5. A network connection as claimed in claim 2, characterized in that only one of the wires (1; 2) in the network connection is surrounded by a tubing used as an insulation.

6. A network connection as claimed in claim 1, characterized in that the wires (1, 2) in the network connection are formed as stranded wires (32, 33), and in that said stranded wires (32, 33) are mutually insulated by means of an insulation (34) or a cladding (36) of one of the stranded wires (32; 33).

7. A network connection as claimed in claim 1, characterized in that the network connection with two wires (1, 2) each has a double form, and in that the two network connections are twisted.

8. A network connection as claimed in claim 1, characterized in that the outer insulation (16; 25; 35) of the network connection is formed in such a way that the position of the two wires (1, 2) in the network connection is visible and in that the twisting of the two wires (1, 2) is interrupted.

9. Use of a twisted double cable as a network connection in a network, in which both a symmetrical, differential data transmission via the two wires (1, 2) and an energy transfer from a terminal of a voltage source via the two wires (1, 2) of the network connection is realized.

10. Use of a cable having at least two wires (1, 2) for electrically connecting network users (3, 4, 5, 6, 7) in a network, wherein the network connection has a symmetrical structure and the two wires (1, 2) are twisted, the wires (1, 2) being mutually insulated to such an extent (13; 21, 22; 34; 35) that they are suitable for a symmetrical, differential data transmission, the two wires (1, 2) having the same electrical resistance and jointly having a cross-section which is suitable for energy transfer from a terminal of a voltage source to network users (3, 4, 5, 6) via both wires (1, 2).

11. Use of a network connection as claimed in any one of claims 1 to 8, wherein the positive terminal is coupled to the network users via the network connection, and wherein the negative terminal of the voltage source is coupled to the network users via the chassis of the vehicle.

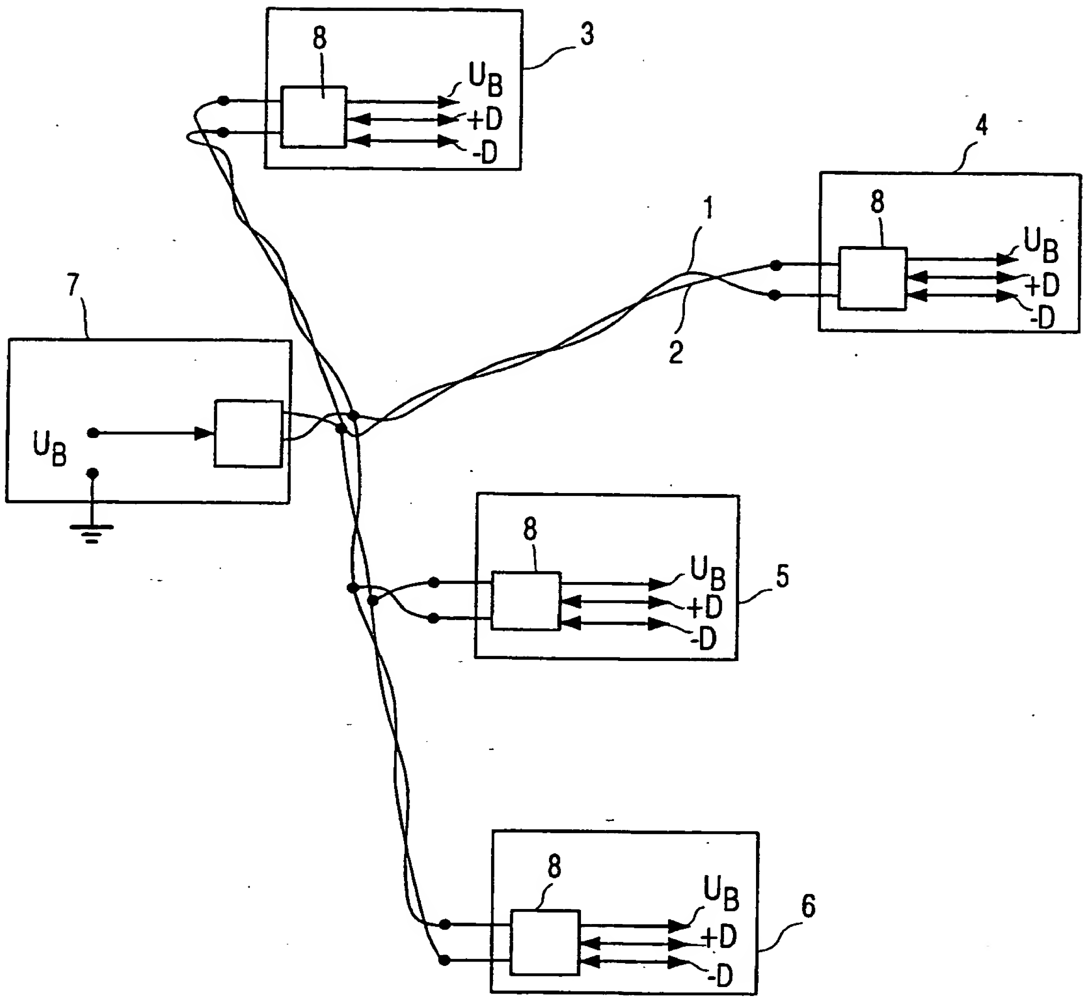

FIG. 1

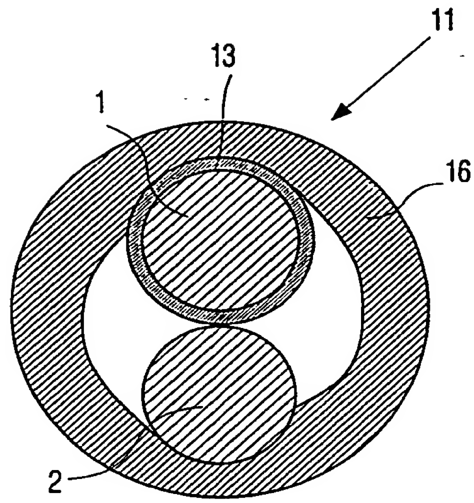

FIG. 2

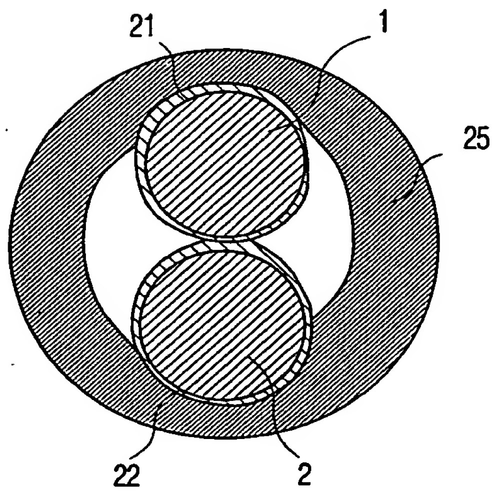

FIG. 3

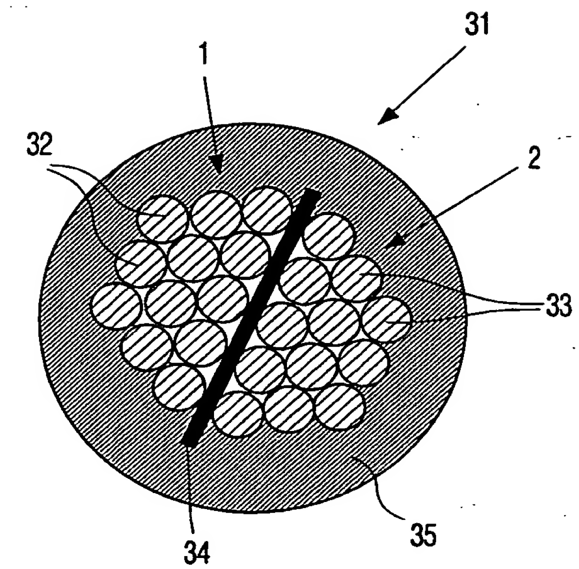

FIG. 4A

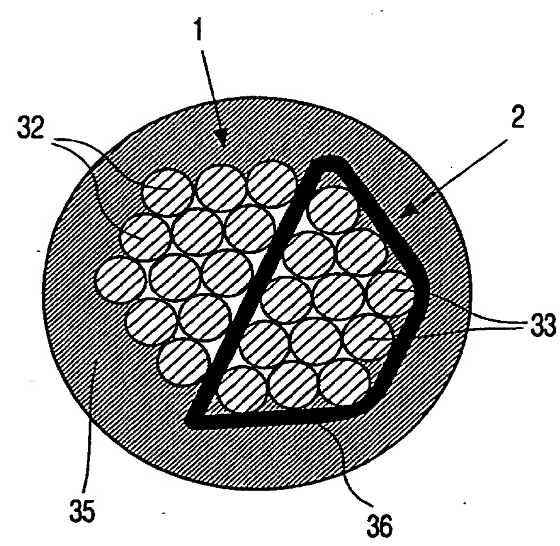

FIG. 4B

INTERNATIONAL SEARCH REPORT

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IPC 7 H04B3/54

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	De Iulis, M

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Date of the actual completion of the international search	Date of mailing of the international search report
30 November 2000	07/12/2000

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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PCT/EP 00/09197

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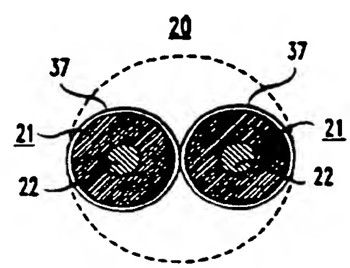
(54) **Twisted pairs of insulated metallic conductors for transmitting high frequency signals and methods of making.**

(57) Methods and apparatus are provided for providing an electrically matched pair (20) of insulated metallic conductors (21, 21). Insulation is applied to successive portions of a length of wire-like metallic conductor (22) after which a colorant material (37) is applied to the surface of a plastic insulation material of a first portion of the length of the metallic conductor which is being moved along a path of travel. Facilities are provided for shielding a supply of the colorant material from the moving insulated metallic conductor and for then exposing a second portion of the length of the insulated metallic conductor to a different colorant material. The insulation and the colorant materials and their disposition with respect to the insulation are such that the dielectric constant of one insulated metallic conductor of the pair is substantially equal to that of the other. The first and second portions of the length of the insulated metallic conductor are separated from each other and are twisted together to provide an electrically matched pair.

FIG. 1



EP 0 520 680 A2

Technical Field

This invention relates to twisted pairs of insulated metallic conductors for transmitting high frequency signals and methods of making same.

Background of the Invention

A technical objective, that is also economically important, is to be able to make a cable comprising a twisted insulated metallic conductor pair or pairs as small as possible that is capable of transmitting data at a maximum rate. In order to provide a twisted pair cable being capable of transmitting digital signals at the highest rate for the maximum distance and also being as small as possible, insulating material with relatively low dielectric constant and low power factor is sought for the metallic conductor.

The advantages of relatively high bit rate transmission can be realized only if electrically balanced pairs can be produced. Pair balance means that one insulated conductor of a pair should be substantially identical to the other -- a difficult objective. In addition to good pair balance, maximizing both bit rate transmission and distance capability requires suitable crosstalk control. This carries with it a need for short pair twists which enhance the electrical characteristics of the pair as well as preventing the pairs from becoming untwisted.

Also desired is the ability to distinguish one conductor of a pair from another by sight. There is a basic conflict between the sight coding of insulated conductors and pair balance needed to provide electrically matched pairs. Sight coding involves making one insulated conductor of a pair appear differently from the other insulated conductor of the same pair. Striving for the required pair balance involves making one insulated conductor of a pair identical in every respect except appearance to the other conductor. The very best pair balances have been achieved with electrically matched pairs, i.e. the two insulated conductors of a pair taken successively from a single length of wire on the same insulating manufacturing line. Although electrically matched pairs produce the very best pair balance, the two resulting conductors have had the same color thereby making it impossible to sight distinguish between them.

Of importance with respect to colored insulation are electrical properties of cable which include such insulated conductors. One electrical property is capacitance. Capacitance is an effect somewhat similar to the magnetic field known to exist around a current-carrying conductor. The capacitive effect results from electrostatic charges on adjacent surfaces, such as metallic conductors in a pair or pairs. Electronic wires and cables by nature develop capacitive effects whenever current is flowing. Although it is impossible to eliminate capacitance, certain factors can be adjusted to achieve an acceptable level.

It is known that the inclusion of different colorant pigments in the composition of the insulation for purposes of distinguishing one conductor of a pair from the other compromises the electrical properties of the insulated conductor discussed hereinbefore. Conductor insulation which has a pigment dispersed throughout adversely affects electrical properties such as capacitance. Pigments of different color concentrates affect capacitance and processing differently. Achieving lower capacitance values has resulted in higher manufacturing costs whereas higher values cause increased attenuation.

The problems of the application of colorant materials to a moving insulated metallic conductor and of the effect of pigments dispersed throughout the insulation on electrical properties of the insulated conductor have been solved by the application of a colorant material to the surface of a moving insulated conductor which may be referred to as topcoating, for example. See U.S. patent 4,877,645.

Topcoating materially reduces scrap rates because the coloring is applied to the outside of the just-insulated conductor and therefore obviates the need to adjust insulating conditions for different colors and also the wasteful purging of an extruder for a color change.

With topcoating, it may be necessary first to tint the insulation with white color concentrates to hide the copper conductor. Here, it may be noted that copper wire can vary significantly from the familiar bright, shiny copper color to a dark, purplish brown. Because many desirable insulating materials are fairly transparent, providing a constant white base is helpful in achieving bright, easily distinguished colors. Placed on a white plastic material, for example, a topcoating satisfactorily produces readily distinguishable colors with acceptable adherence to the insulation and can be produced with acceptable processing yields.

The state of the art then is that there exist excellent materials which may be used for insulation as well as methods for causing these conductors to be identifiable. These materials and methods of coloring are advances in the quest for insulated metallic conductors which can transmit digital signals over long distances at the highest rate.

What is sought after and what seemingly is not provided for in the prior art is an electrically matched insulated metallic conductor pair in which the two insulated conductors of a pair are distinguishable. Desirably the matched pair is made from successive portions of a single length of me-

tallic wire which is processed in sequential steps on an insulating line. Further what is sought after is a differentiation between the conductors of the pair without adversely affecting electrical properties of the insulated metallic conductors.

Summary of the Invention

The foregoing problems of the prior art have been overcome by the electrically matched insulated metallic conductor twisted pair as set forth in claim 1. A method of making such an insulated conductor is set forth in claim 8.

Brief Description of the Drawing

FIG. 1 is an end cross sectional view of an insulated metallic conductor twisted pair which has been enclosed with plastic insulation material and provided with a surface colorant;

FIG. 2 is an electrical schematic representation of two conductors and a shield and showing the capacitance between metallic elements thereof;

FIG. 3 is a schematic view of a manufacturing line for making a continuous length of insulated metallic conductor having successive portions thereof colored differently;

FIG. 4 is a perspective view of apparatus for applying a colorant material to a moving insulated metallic conductor;

FIG. 5 is an enlarged view of one of a plurality of nozzles for supplying a colorant material to a moving insulated metallic conductor;

FIG. 6 is a perspective view of an arrangement of two sets of nozzles for applying a colorant material to a moving insulated metallic conductor; and

FIG. 7 is a front elevational view of a colorant application apparatus which includes provisions for changing colorant materials which are applied to a moving insulated metallic conductor.

Detailed Description

Referring now to FIG. 1, there is shown an electrically matched insulated metallic conductor twisted pair designated generally by the numeral 20. The twisted pair 20 includes two identifiable insulated metallic conductors 21-21, each including a metallic conductive portion 22, which have been twisted together with a desired twist length. Each insulated conductor of the pair is visually distinguishable from the other conductor of the pair.

Capacitance balance or unbalance of twisted pairs has long been studied in connection with combating interferences to voice and carrier frequencies. However, one aspect of capacitance balance, balanced dielectric constant, becomes increasingly important as the transmitted frequencies increase. Twisted pairs now are to be used to transmit 100 megabit per second Fiber Distributed Data Interface (FDDI) signals and have been shown to be suitable to transmit one gigabit per second signals. It will be of importance in transmitting these frequencies that the distinguishable insulations of the two conductors of a pair have nearly identical dielectric constants.

Referring now to FIG. 2 the mutual capacitance of an insulated metallic conductor pair is the sum of the capacitance of one conductor to the other, C_D, and the series combination of the capacitance of each conductor to earth. The capacitance of one conductor of the pair to the other conductor, is important but does not contribute to the capacitance to earth. A twisted pair is said to have perfect capacitance balance if the capacitance of one conductor to earth,

$$C_{G_1},$$

is equal to the capacitance of the other conductor to earth,

$$C_{G_2}.$$

Assuming that the elements of the pair are circular and concentric, the capacitance to earth is a function of the conductor diameter, the insulation diameter, the distance of the pair to ground or to a shield, and the dielectric constant of the insulation. From voice frequencies to about 100 kHz, simple capacitance balance is adequate to cancel interferences. However, differences in the dielectric constant of the insulations of the two conductors become increasingly important, possibly even controlling, as the transmitted frequencies increase and as the series combination of the capacitance of each conductor to earth increases.

The importance of equal dielectric constant between insulated conductors of a pair is a function of two parameters, i.e. the system in which the pair is to be used and the pair design. As will be discused hereinafter, a measure of the system importance is the number of wavelengths between a signal source and a receiver.

With regard to pair design, equal dielectric constant of the insulations of the two conductors is least important in designs in which most of the mutual capacitance is due to the capacitance between conductors and is most important in designs in which most of the mutual capacitance is due to the capacitances of the conductors to ground. In other words, the sensitivity of a design to variation in dielectric constant is measured by the ratio

$$C_{G_1}/C_D \text{ or } C_{G_2}/C_D.$$

An unshielded twisted pair suspended in air represents a design least susceptible to dielectric constant variations. An individually shielded pair represents a design most susceptible to these variations. While the two extreme designs may differ by an order of magnitude in their susceptibility, uniform dielectric constant becomes important for any twisted pair design when transmitting at very high bit rates. The greater the proportion of mutual capacitance that is due to the series combination of capacitance of each conductor to earth, the more important it becomes to have equality between the dielectric constants of the conductor insulation covers of a twisted pair.

A pair design which has mutual capacitance consisting solely of capacitance to ground without any direct conductor-to-conductor capacitance may be formed by twisting together two coaxial cables. It is well known that a high frequency signal in a coaxial cable propagates at the velocity of light divided by the square root of the dielectric constant. Consider two cases. The first is one in which the frequency and the distance between signal source and receiver are such that there are 10 wavelengths in the span, and the second is one in which the frequency and distance between signal source and receiver are such that there are 100 wavelengths in the span. In the first case there is 3,600° of phase shift between source and receiver. In the second case there is 36,000° of phase shift between source and receiver. If a phase difference of, say, 6° is critical, the first system requires that the signal velocities of the two conductors be matched to 6/3,600, or one part in 600. The second system requires that the signal velocities be matched to 6/36,000 or one part in 6000. Thus, it is clear that the greater the number of wavelengths between signal source and receiver, the more critical becomes the match between the phase velocities, and therefore the dielectric constants, of the two insulated conductors of a pair.

Good pair balance entails the same ratio of the diameter of the insulated conductor to the diameter of the metallic conductor for both insulated conductors and substantially the same dielectric constant, both of which are achieved with the present invention. A uniform dielectric constant is especially critical because each conductor of the pair carries half the signal and each half must maintain its phase with respect to the other half. A uniform dielectric constant may be achieved by causing the conductor insulation and any distinguishment means such as colorant material to be uniform along the two lengths which comprise the twisted pair.

Going now to FIG. 3, a wire-like metallic conductor 22 is moved along an insulating line 23 from a supply reel 24 and advanced through a drawing apparatus 25 wherein the diameter of the wire is reduced. Thereafter, it is annealed in an annealer 26, then cooled and reheated to a desired temperature after which is it moved into and through an extruder 28.

In the extruder 28, a plastic insulating material is applied to the moving wire to enclose it to provide an insulated metallic conductor 30. The details of the structure of the drawing apparatus, annealer and extruder are all well known in the art and do not require elaboration herein. Afterwards, the plastic insulated wire is moved through a cooling trough 31 by a capstan 33 and onto a takeup 35. A conventional marking device 32 may be used to apply a band marking to the insulation.

Desirably, the insulating material is a clear or neutral color or a white color plastic fluoropolymer material. With these criteria in mind, Teflon® plastic material is clearly an example of one of the best available insulation materials. Also, it is an excellent material in terms of strength, resistance to chemical attack and fire retardancy. In the preferred embodiment, the insulating material may be perfluoroalkoxytetrafluoroethylene (PFA), fluorinated ethylene-propylene (FEP) or ethylene tetrafluoroethylene copolymer (ETFE).

Teflon plastic material can be pigmented with a white color concentrate. Some advantages of having only a white color insulation are ease of processability, ease of coloring, hiding power of copper variability and uniformity of electrical properties. Some color concentrates other than white are more difficult to process. Also, a complete palette of colors made using color concentrates would entail unwanted variations in dielectric properties

There are insulation materials other than Teflon plastic which will benefit from this manufacturing process and will provide similar electrical advantages. Other such insulation materials include polyethylene, polypropylene, and HALAR® fluoropolymer.

Teflon plastic material has proven difficult to color by pigmenting throughout the insulation with color concentrates. Color concentrates for colors that present the most problems have two melt phases. If temperatures are raised enough to obtain complete melting, gases are produced; at lower temperatures, small unmelted chunks appear as inclusions in the insulation.

Variability between different colored color concentrates, which typically have been included in the insulation, causes variations in capacitance. However, the greater the distance from the metallic conductor, the less effect there is on the capaci-

tance. Thus, pigment variability for a topcoated insulated conductor has an insignificant effect on the capacitance of the pair because of the distance of the surface coating to the metallic conductors.

Between the extruder 28 and the takeup 35, a colorant material 37 (see FIG. 1) is applied such as in a layer to an outer surface the plastic insulated wire and provide an identifiable insulated conductor 21. The location along the line 23 where it is applied depends on the kind of plastic material comprising the extrudate. Inasmuch as in the preferred embodiment, the insulation comprises a fluoropolymer, which is non-porous, the colorant material is applied at a location between the extruder 28 and the cooling trough 31.

Notwithstanding its location, a colorant material application apparatus 40 is included in the line 23 and is effective to apply a colorant material to cover substantially the entire surface area of the moving insulated conductor 30. Advantageously, the application apparatus 40 is a non-contact device. Preferably, the colorant material is an ink such as No. 3516, for example, commercially available from GEM Gravure Co. of West Hanover, Mass.

As can best be seen in FIG. 4, the apparatus 40 includes a manifold head 42 which is connected to a source of supply (not shown) of colorant material. The manifold head 42 has an annular shape to allow the plastic insulated conductor to be advanced therethrough. Extending from one side of the manifold head 42 are a plurality of tubular support members 44-44 which are connected through the manifold head to the source of supply. Attached to each tubular member 44 is a nozzle 46 which has an entry port that communicates with the passageway through its associated tubular member.

Each nozzle 46 is one which is adapted to provide a particular spray pattern of the colorant. Preferably the nozzle 46 emits colorant material therefrom in a single plane or sheet 45 (see FIGS. 4 and 5).

Also, each nozzle 46 is positioned on its associated tubular member to emit its spray in a plane which is at a particular angle α (see FIG. 5) to the path of travel of the plastic insulated wire. The angle α is such that the spray has a component parallel to the path of travel of the insulated wire but in a direction opposite to the direction of movement of the insulated wire. Preferably, that angle α is in the range of about 105° to 135°. Because of the direction of the spray pattern, the velocity components tend to provide a smoothing action on the ink and thereby prevent excessive buildup. The result is a surface having a substantially uniform coating thereon.

It should be also observed that in addition to the predetermined angle at which the nozzles are disposed, there are other factors about their positions which are important (see again FIGS. 4 and 5). First, the nozzles are staggered along the path of travel of the plastic insulated wire. The staggered arrangement prevents interference among the spray patterns. Secondly, the nozzles are generally equiangularly spaced about the periphery of the plastic insulated wire. Thirdly, each of the nozzles is spaced about one half inch from the path of travel of the insulated wire. It has been found that as the distance increases beyond one half inch, less coverage of the plastic insulation with the ink is experienced.

Movement of the nozzles toward or away from the insulated wire 21 may be accomplished with an arrangement depicted in the aforementioned U.S. patent 4,877,645.

The nozzles 46-46 also are advantageous from another standpoint. Important to the uniform coating of the plastic insulation is its improved stability against undesired undulations as it is advanced through the applicator apparatus. It has been found that because of the spray patterns emitted from the nozzles 46-46, the plastic insulated wire is substantially free of any undulations from its desired path.

It should be observed from the drawings that the nozzles 46-46 are disposed between the manifold head 42 and the takeup. It has been found that the coloring operation is enhanced by disposing a second plurality 51 of spray nozzles (see FIG. 6) between the manifold head 42 and the extruder 28. Each of the nozzles of the second plurality 51 is designated by the numeral 50.

Unlike the nozzles 46-46, each of the nozzles 50-50 provides a solid cone-shaped spray pattern 53 of the colorant material. Each nozzle 50 provides a uniform spray of medium to large size droplets. Such a nozzle is commercially available, for example, from the Spraying System Company of Wheaton, Illinois under the designation Full Jet® nozzle. Spray angles between opposed lines on the outer surface of the spray pattern may be in the range of from about 40° to about 110°.

Also as can be seen in FIG. 6, each nozzle 50 is supported from a tubular member 52 which projects from the manifold head 42. Colorant material provided to the head 42 is caused to flow through each of the tubular members 52-52 and to the nozzles 50-50.

The nozzles 50-50 are disposed to reduce interference among the spray patterns and to enhance the coverage of the colorant material on the surface of the plastic insulated wire. As can be seen in FIG. 6, the nozzles are staggered along the path of travel of the plastic insulated wire such that the spray patterns are spaced apart. Also, the nozzles 50-50 are arranged about the path of travel

of the insulated wire so that each is directed in a different radial direction and preferably so that they are spaced equiangularly about the moving wire.

Although the nozzles 50-50 enhance the coverage of the surface area of the plastic insulation, they also tend to cause undulatory movement of the traveling insulated wire. However, this effect is muted by the nozzles 46-46 each of which provides a sheet spray.

The system of this invention includes facilities for effecting cutover from one colorant material to another as the insulated wire continues to be moved along the path of travel. A second manifold head 58 (see FIG. 7) identical to the manifold head 42 and having first and second pluralities of nozzles is provided. Further, a shroud 60 which is mounted for reciprocal movement by an air cylinder 62, for example, is interposed between the two manifold heads. The manifold head 58 is operative to supply colorant to its associated nozzles to coat the wire insulation. When it is desired to change colors, the flow of colorant material to the head 42 currently not in use is begun and the air cylinder is controlled to cause the shroud to be moved to the right as viewed in FIG. 7 to shield the moving insulated wire from the nozzles 46-46 and 50-50 of the head 58. The colorant material to the head 42 from which the shroud has been moved is sprayed by its associated nozzles onto the moving insulated wire. Shortly, afterwards, the flow of colorant material to the head 58 is discontinued.

Advantageously, the shroud arrangement may be used to facilitate the cleaning of the apparatus. When one of the heads 42 or 58 is not in use and its nozzles shrouded from the moving insulated wire, a cleaning liquid is flowed through the tubular members and nozzles of the unused head to clean them.

Because of the cutover facilities of FIG. 7, a continuous length of insulated metallic conductor may have different colorant materials applied to successive portions of the length thereof. Subsequently, two portions of the insulated metallic conductor are separated from each other and the two portions twisted together by an apparatus well known in the art to provide an electrically matched pair manufactured on the same line and from a single run of an insulated metallic conductor with no other variables being introduced.

In the alternative, when the cutover apparatus of FIG. 7 is controlled to change from one application head to another, an automatic takeup apparatus is controlled to cause a cutover to another takeup reel after a predetermined time. That time is needed for the length of insulated conductor colored by the first head to be advanced onto one takeup reel before cutover to a second takeup reel. Subsequently, the two reels are mounted in a twisting apparatus (not shown) which is operated. to cause the two lengths of differently colored conductor lengths to be twisted together.

As a result of the foregoing methods, an electrically matched twisted pair is provided. The insulation applied by the same extruder to successive portions of length of a metallic conductor and the colorant material applied to an outer surface of each insulated portion results in substantially equal dielectric constants between the two colored, insulated conductors. Of significant importance to the capability of distinguishing between two successive portions of the length of the metallic conductor is the ability to be able to shift quickly from the application of a form of identification to another such as the ability to change colorant materials quickly.

Claims

1. An electrically matched, insulated metallic conductor pair which is suitable for the transmission of relatively high frequency signals, said conductor pair comprising first and second insulated metallic conductors each comprising a metallic conductor, and an insulation material which covers the metallic conductor; said matched conductor pair being characterized by said first metallic conductor being distinguishable from said second insulated metallic conductor and the dielectric constant of the insulation material which is disposed about the metallic conductor of the first insulated metallic conductor and any identifiable marking associated therewith being substantially equal to the dielectric constant of the insulation material which is disposed about the metallic conductor of the second insulated metallic conductor and any identifiable marking associated therewith; and

    further said first and second insulated metallic conductors comprising successive portions of a continuous length of metallic conductor which has been insulated in a single run on a manufacturing line.

2. The matched insulated metallic conductor twisted pair of claim 1, wherein

    a surface layer of a colorant material is confined substantially to an outer surface of the insulation material of each insulated conductor maximizing the distance of each metallic conductor to the colorant material, the colorant material of the second insulated conductor being distinguishable from the colorant material of said first insulated metallic conductor.

3. The electrically matched pair of claim 2,

wherein the insulation material of each insulated conductor is substantially non-porous.

4. The electrically matched pair of claim 2, wherein said surface layer of each insulated conductor comprises an ink.

5. A method of making an electrically matched, twisted pair of insulated metallic conductors, said method comprising the steps of causing relative motion between a length of metallic conductor and a source of insulating material along a path of travel in a direction along the longitudinal axis of the metallic conductor corner; while applying an insulating material to successive portions of the length of metallic conductor to provide a length of insulated metallic conductor, said method being characterized by the steps of:

causing a portion of the length of the insulated metallic conductor to be distinguishable from the insulation material of a successive portion of the length such that the dielectric constant of the insulation material which is disposed about the metallic conductor of said portion and any identifiable marking associated therewith is substantially equal to the dielectric constant of the insulation material which is disposed about the metallic conductor of said successive portion and any identifiable marking associated therewith; and

twisting together the successive portions of the length of the insulated metallic conductor to provide an electrically matched pair.

6. The method of claim 5 said method comprising the steps of:

causing relative motion between the length of insulated metallic conductor and a source of colorant materials along a path of travel in a direction along the longitudinal axis of the insulated metallic conductor; while

directing a spray pattern of a first colorant material toward the first portion of the length of the insulated metallic conductor to cause the first colorant material to be applied to the first portion of the length of the insulated metallic conductor;

directing a spray pattern of a second colorant material toward the second, successive portion of the length of the insulated metallic conductor to apply the second colorant material to the second, successive portion of the length;

taking up the first and second portions of the length of the insulated metallic conductor; and

twisting together the two successive portions of the length of the surface colored insulated metallic conductor to provide an electrically matched pair.

7. The method of claim 5, which includes the steps of

directing spray patterns of one colorant material toward the first portion of the length of the insulated metallic conductor in such a manner that at least each of a plurality of the spray patterns occupies only an area of a plane and such that the direction of each of the plurality of spray patterns is at a predetermined angle to the path of travel, the plurality of spray patterns of the plurality being staggered along and spaced generally equiangularly about the path of travel and cooperating to prevent unintended undulations of the insulated metallic conductor as the relative motion is caused to occur, wherein the one colorant material is moved from a source into a manifold and distributed to each of a plurality of spray nozzles and said method further includes the steps of interposing a shield between the insulated metallic conductor and the nozzles of the manifold and thereafter causing another colorant material to be emitted from nozzles associated with another manifold and directed toward the second portion of the length of the insulated metallic conductor; then

taking up the first and second portions of the length of surface colored insulated metallic conductor; and

twisting together the two successive portions of the length.

8. The method of claim 7, wherein first and second pluralities of spray patterns are associated with each manifold arranged along the path of travel with the spray patterns of each plurality being spaced apart along the path of travel, the spray patterns of the first plurality each being in a single plane and at a predetermined angle to the path of travel.

9. The method of claim 8, wherein each of the second plurality of spray patterns has a solid conical shape.

10. The method of claim 7, wherein the distance between the point at which each spray pattern is emitted and the insulated metallic conductor may be varied.

FIG. 1

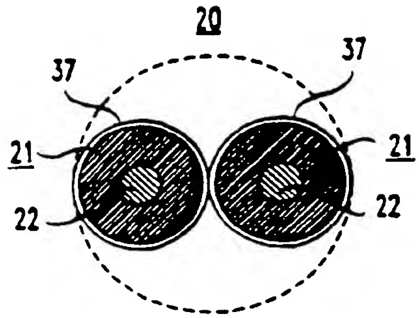


FIG. 3

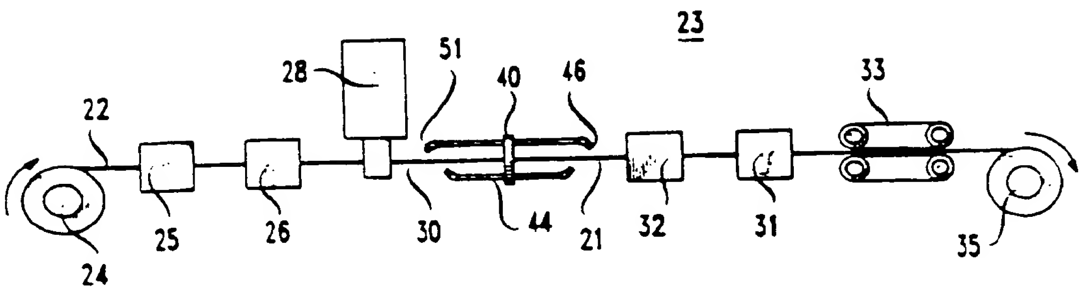


FIG. 5

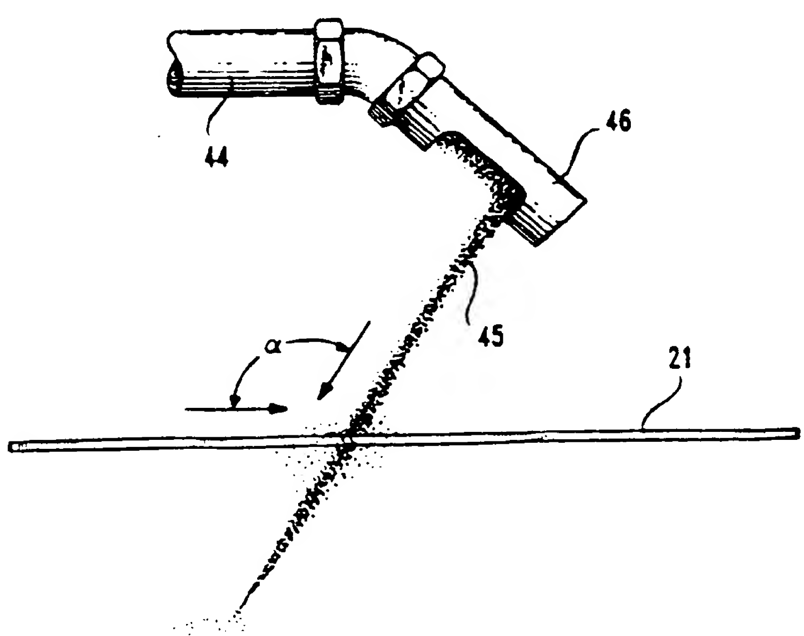


FIG. 4

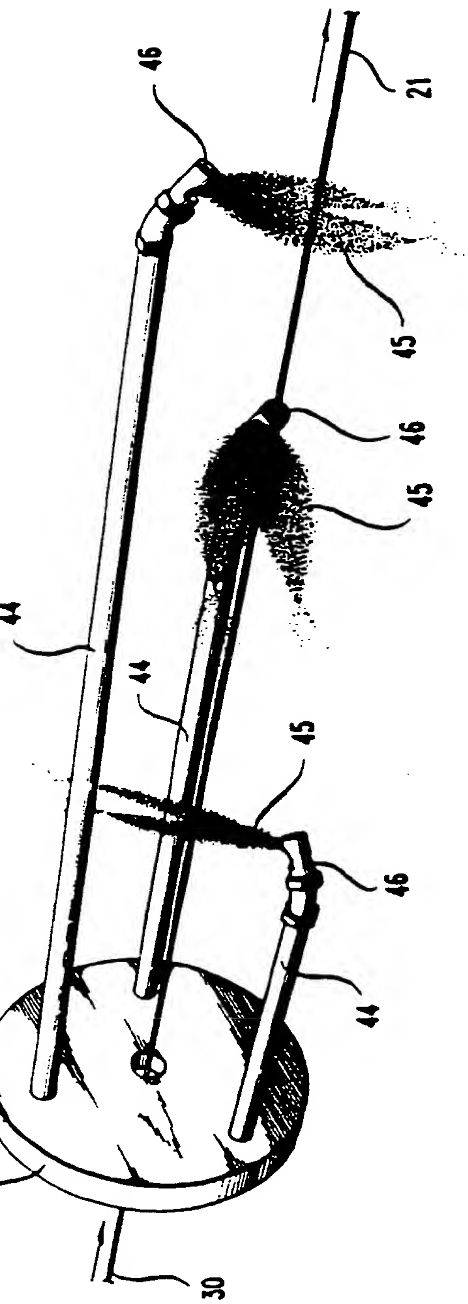

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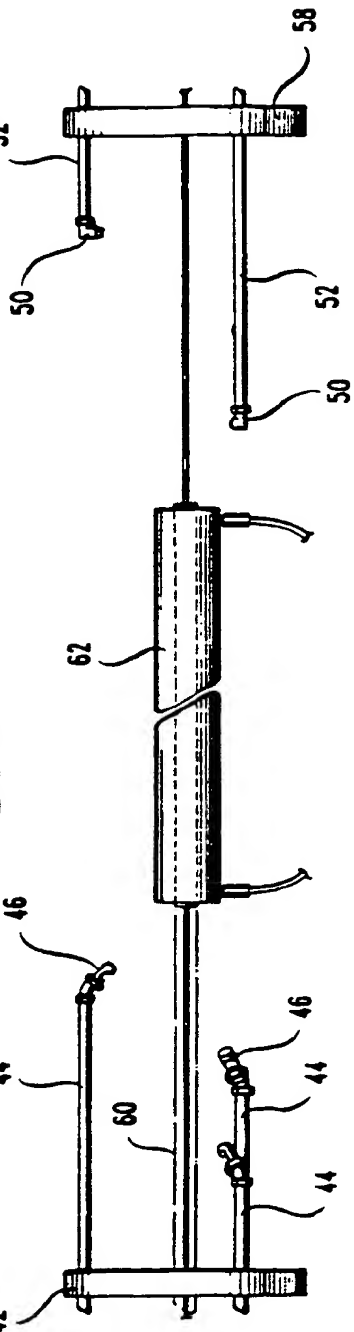
FIG. 7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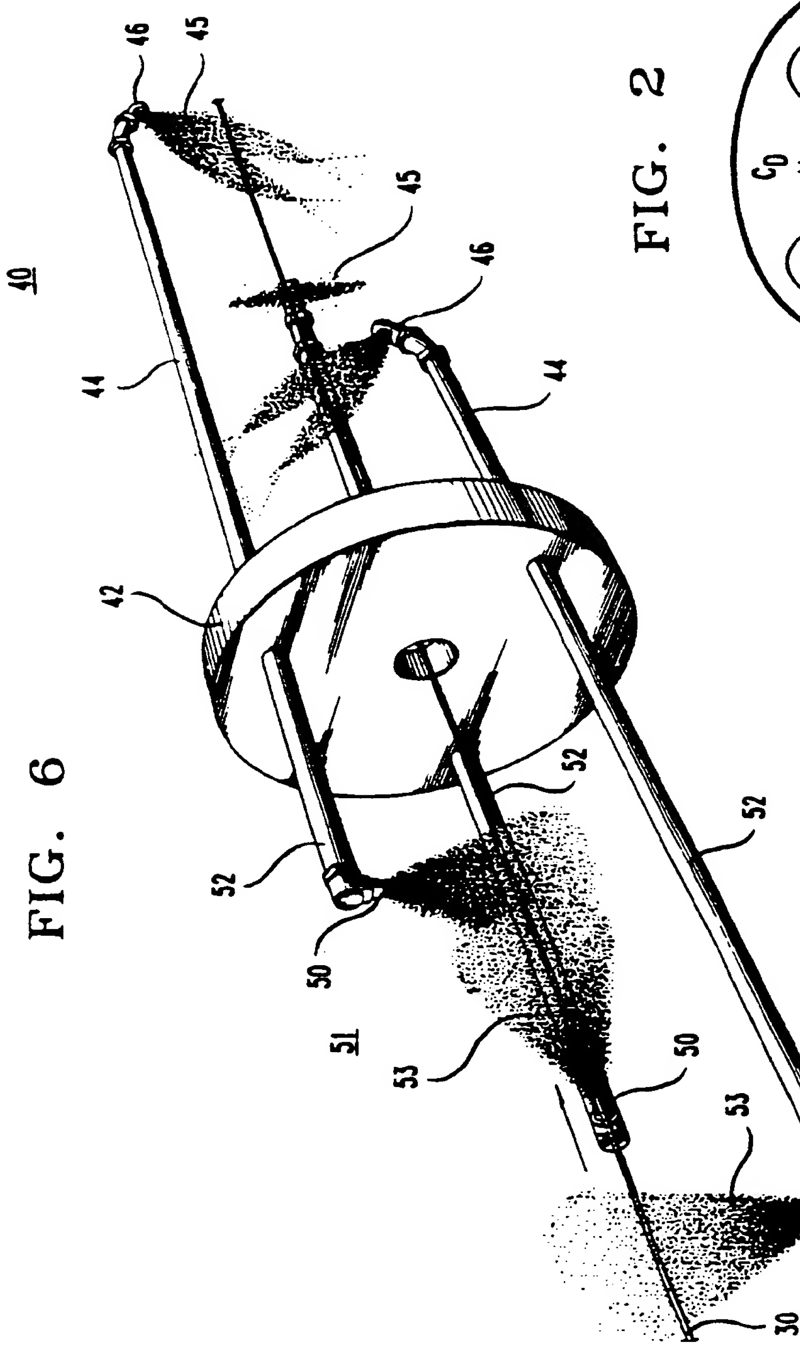

FIG. 6

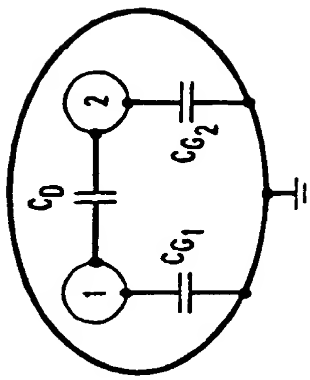

FIG. 2

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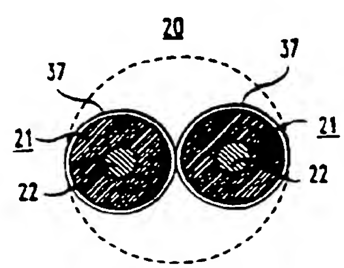
(54) Twisted pairs of insulated metallic conductors for transmitting high frequency signals and methods of making.

(57) Methods and apparatus are provided for providing an electrically matched pair (20) of insulated metallic conductors (21, 21). Insulation is applied to successive portions of a length of wire-like metallic conductor (22) after which a colorant material (37) is applied to the surface of a plastic insulation material of a first portion of the length of the metallic conductor which is being moved along a path of travel. Facilities are provided for shielding a supply of the colorant material from the moving insulated metallic conductor and for then exposing a second portion of the length of the insulated metallic conductor to a different colorant material. The insulation and the colorant materials and their disposition with respect to the insulation are such that the dielectric constant of one insulated metallic conductor of the pair is substantially equal to that of the other. The first and second portions of the length of the insulated metallic conductor are separated from each other and are twisted together to provide an electrically matched pair.

FIG. 1



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EUROPEAN SEARCH REPORT

Application Number

EP 92 30 5578

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	GB-A-229 788 (BRITISH INSULATED & HELSBY CABLES) * the whole document * ---	1	H01B11/00 H01B13/02
A	US-A-5 015 800 (VAUPOTIC ET AL.) * abstract; figures 1-3 * ---	1,3,5	
A,D	US-A-4 877 645 (BLEICH ET AL.) * the whole document * ---	1,3,4	
A,P	EP-A-0 450 789 (A.T.T.) * the whole document * -----	1,3,4	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

H01B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29 JANUARY 1993	DEMOLDER J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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The invention relates to a network connection comprising at least two wires for electrically connecting network users in a network.

Known network connections are constructed in such a way that they are suitable for data transmission through the two wires of the network connection. This has the drawback that both terminals of an energy power supply for the network users are to be realized via separate electric connections.

It is an object of the invention to provide a network connection which is suitable for both data transmission and energy transfer.

According to the invention, this object is solved in that the network connection has a symmetrical structure and the two wires are twisted, in that the wires are mutually insulated to such an extent that they are suitable for a symmetrical, differential data transmission, and in that the two wires have the same electrical resistance and jointly have a cross-section which is suitable for energy transfer from a terminal of a voltage source to network users via both wires.

In this network connection, data can be transmitted through the two wires. Moreover, the energy transfer can jointly take place through the two wires in that a terminal of a voltage source is coupled to the two wires so that energy transfer to the network users can take place through these wires.

For the energy transfer, the two wires jointly have such a cross-section that they are suitable for the currents flowing in response to the energy transfer.

The data transmission is advantageously realized symmetrically and differentially. To this end, the two wires are mutually insulated. This insulation should only be sufficient for the relatively low data transmission voltages. It should particularly not be suitable for relatively high voltages of a power supply for the network users, because only one pole of a voltage source is jointly coupled through the two wires.

Moreover, the two wires have the same electrical resistance in order that the symmetrical differential data transmission through the two wires has the same resistance. Moreover, the data transmission is thus not disturbed by the potential jumps which may occur as a result of the energy transfer.

The network connection has a symmetrical construction. This results in a high attenuation of disturbances of the power supply lines, which is achieved via a cancelling means ("Auslöschung").

To achieve a satisfactory decoupling with respect to external electric and magnetic fields, the two wires are advantageously twisted. This results in an improved mutual magnetic coupling of the two wires, which contributes to the signal-to-noise ratio of the data transmission.

Since the load current for the energy supply is jointly passed through the two wires of the network connection, it is not desirable to use additional copper for this purpose. The overall cross-section of the two wires must only be chosen to be as large as the cross-section of a wire of a separate cable connection for the energy transfer.

For the insulation between the two wires, a thin, inexpensive insulation is admissible because, on the one hand, only the low data transmission voltages are to be insulated and, on the other hand, only the communication rather than the energy supply drops out, even in the case of a failing insulation.

As described in an embodiment as defined in claim 2, only one of the wires may be provided with an insulation for this purpose.

Since the insulation can be formed in a relatively simple manner, a lacquer coating, a synthetic material coating or a tubing may be provided as insulations, as described in further embodiments of the invention.

When stranded wires are used, they can be advantageously insulated by means of a cladding of one of the stranded wires or by means of an insulation between the two stranded wires, as described in a further embodiment of the invention as defined in claim 6.

The network connection according to the invention may also be in a double form, as defined in claim 7. A pole for the energy supply is then coupled via one of the network connections. The data transmission may be realized in a redundant form through the two network connections so that the transmission reliability is enhanced.

To simplify a contact of the network connection, for example, to a network coupler, the outer insulation and the twisting of the wires may be advantageously formed as defined in claim 8.

The network connection according to the invention can be advantageously used in vehicles in which a pole for the power supply is coupled via the chassis of the vehicle. Then, both the data transmission and the power supply for the other pole can take

place via the network connection according to the invention. An additional cable connection with two wires for the power supply can then be dispensed with.

These and other aspects of the invention are apparent from and will be elucidated with reference to the embodiments described hereinafter.

In the drawings:

Fig. 1 shows a network comprising a plurality of network users, among which a network connection according to the invention is established,

Fig. 2 is a cross-section through a first embodiment of a network connection according to the invention, in which only one wire is insulated,

Fig. 3 is a cross-section through a second embodiment of a network connection according to the invention, in which both wires are provided with a thin lacquer coating, and

Fig. 4 is a cross-section through a third embodiment of a network connection according to the invention, in which the wires are formed as stranded wires.

Fig. 1 shows a network connection according to the invention, with two wires 1 and 2. The network connection has a star-shaped configuration and interconnects a plurality of network users 3, 4, 5 and 6. A further network user 7 is provided which is coupled to a terminal of a voltage source U_B and couples this terminal into the two wires 1 and 2 of the network connection.

Via network couplers 8, the network users 3, 4, 5 and 6 are capable of coupling out the required energy symmetrically from the two wires 1 and 2 of the network connection. Furthermore, the network users 3, 4, 5 and 6 transmit data via the two wires 1 and 2 of the network connection according to the invention, which is coupled in and coupled out via the network couplers and is formed in such a way that the data are transmitted symmetrically and differentially through the two wires 1 and 2.

The other terminal of the voltage source U_B may be connected, for example, to the chassis of the vehicle comprising the network users 3 to 7.

The circuit diagram shown in Fig. 1 illustrates that an additional cable connection with two wires for the transfer of energy may be dispensed with in the network connection according to the invention. One terminal for the power supply is coupled via the

two wires 1 and 2 of the network connection according to the invention, and the other terminal is coupled via the chassis of the vehicle.

Due to the specific construction of the two wires 1 and 2 of the network connection according to the invention, which will be further described hereinafter, these wires 1 and 2 are also simultaneously suitable for a symmetrical, differential data transmission.

This is particularly achieved in that the two wires 1 and 2 are symmetrical and the energy is transferred symmetrically through the two wires. Disturbances caused by the energy transfer thus do not affect the data transmission, because the differential, symmetrical transmission cancels the disturbances during the evaluation of the data transmission.

The two wires 1 and 2 are mutually twisted so as to achieve a satisfactory decoupling from external electric magnetic fields. Moreover, the magnetic coupling between the two wires is thereby improved.

The mutual insulation of the two wires may be relatively simple and thin because this insulation should only insulate the relatively low data transmission voltages. Since a pole for the power supply is jointly coupled through the two wires, these relatively high currents or voltages do not require insulations between the wires.

Fig. 2 is a cross-section through a first embodiment 11 of a network connection according to the invention, with two wires 1 and 2. The two wires have the same cross-section and are electrically constructed in such a way that they have the same resistance.

In the embodiment shown in Fig. 2, only one of the wires, namely the wire 1, is provided with a thin outer insulation 13. This insulation 13 may be, for example, an insulating tubing or a lacquer coating. This insulation 13 should only be formed in such a way that it is adequate for the opposite data transmission voltages occurring in the two wires 1 and 2, which voltages are, however, relatively small.

Furthermore, a joint outer insulation 16 is provided.

The two wires 1 and 2 are mutually twisted in a way which is not further shown in Fig. 2.

To make optically optimal connection points, for example, for network couplers or the like visible in the network connection, the outer insulation 16 may be advantageously formed in such a way that the position of the two wires 1 and 2 in the network connection is visible, i.e. the twisting is recognizable from the exterior. Moreover,

the twisting of the two wires may be advantageously interrupted so as to provide optimal connection points on the two wires 1 and 2.

The cross-section through the first embodiment of the network connection according to the invention, as shown in Fig. 2, illustrates that both a data transmission and a terminal for a voltage source can be established via a network connection which is actually built up in a relatively simple manner, in which even the mutual insulation of the wires may be relatively simple.

This is also shown by a second embodiment shown also in a cross-section in Fig. 3 of a network connection according to the invention which also comprises two wires 1 and 2. However, in the second embodiment shown in Fig. 3, both wires 1 and 2 are provided with a thin outer insulation 21 and 22, respectively. For example, a thin lacquer coating which can be provided in a relatively easy way is sufficient for this purpose. Basically, this insulation may also consist of a synthetic material coating. It is alternatively possible to slide, for example, thin tubings on one or both wires 1 and 2.

The complete network connection is surrounded by an outer insulation 21.

Fig. 4 also shows, in a cross-section, an embodiment of a network connection according to the invention, in which the two wires 1 and 2 are constituted by stranded wires 32 and 33.

In Fig. 4A, the stranded wires 32 and 33 are mutually separated and insulated by means of an insulation 34. The complete stranded wires 32 and 33 are embedded in an insulation 35 so that they cannot move with respect to each other, and the insulation 34 ensures a safe insulation of the two stranded wires 32 and 33 forming part of the two wires 1 and 2.

Fig. 4B is similar to Fig. 4A, showing wires 1 and 2 constituted by stranded wires 32 and 33. However, in this case, not only an insulation 34 as in Fig. 4A is provided but also a cladding for one of the stranded wires. In the embodiment shown in Fig. 4B, the stranded wires 33 of the second wire 2 are completely insulated from the exterior by this cladding 36. Here again, the two stranded wires 32 and 33 are embedded in an outer insulation 35.

All embodiments shown in the Figures show that the network connection according to the invention may have a relatively simple structure because only a simple insulation between the wires 1 and 2 is required. Nevertheless, it is suitable for data transmission as well as for energy transfer.

CLAIMS:

1. A network connection comprising at least two wires (1, 2) for electrically connecting network users (3, 4, 5, 6, 7) in a network, characterized in that the network connection has a symmetrical structure and the two wires (1, 2) are twisted, in that the wires (1, 2) are mutually insulated to such an extent (13; 21, 22; 34; 35) that they are suitable for a symmetrical, differential data transmission, and in that the two wires (1, 2) have the same electrical resistance and jointly have a cross-section which is suitable for energy transfer from a terminal of a voltage source to network users (3, 4, 5, 6) via both wires (1, 2).

2. A network connection as claimed in claim 1, characterized in that only one wire (1; 2) in the network connection is provided with an insulation (13; 21).

3. A network connection as claimed in claim 2, characterized in that only one of the wires (1; 2) in the network connection is provided with a lacquer coating (21) used as an insulation.

4. A network connection as claimed in claim 2, characterized in that only of the wires (1; 2) in the network connection is provided with a synthetic material coating (13) used as an insulation.

5. A network connection as claimed in claim 2, characterized in that only one of the wires (1; 2) in the network connection is surrounded by a tubing used as an insulation.

6. A network connection as claimed in claim 1, characterized in that the wires (1, 2) in the network connection are formed as stranded wires (32, 33), and in that said stranded wires (32, 33) are mutually insulated by means of an insulation (34) or a cladding (36) of one of the stranded wires (32; 33).

7. A network connection as claimed in claim 1, characterized in that the network connection with two wires (1, 2) each has a double form, and in that the two network connections are twisted.

8. A network connection as claimed in claim 1, characterized in that the outer insulation (16; 25; 35) of the network connection is formed in such a way that the position of the two wires (1, 2) in the network connection is visible and in that the twisting of the two wires (1, 2) is interrupted.

9. Use of a twisted double cable as a network connection in a network, in which both a symmetrical, differential data transmission via the two wires (1, 2) and an energy transfer from a terminal of a voltage source via the two wires (1, 2) of the network connection is realized.

10. Use of a cable having at least two wires (1, 2) for electrically connecting network users (3, 4, 5, 6, 7) in a network, wherein the network connection has a symmetrical structure and the two wires (1, 2) are twisted, the wires (1, 2) being mutually insulated to such an extent (13; 21, 22; 34; 35) that they are suitable for a symmetrical, differential data transmission, the two wires (1, 2) having the same electrical resistance and jointly having a cross-section which is suitable for energy transfer from a terminal of a voltage source to network users (3, 4, 5, 6) via both wires (1, 2).

11. Use of a network connection as claimed in any one of claims 1 to 8, wherein the positive terminal is coupled to the network users via the network connection, and wherein the negative terminal of the voltage source is coupled to the network users via the chassis of the vehicle.

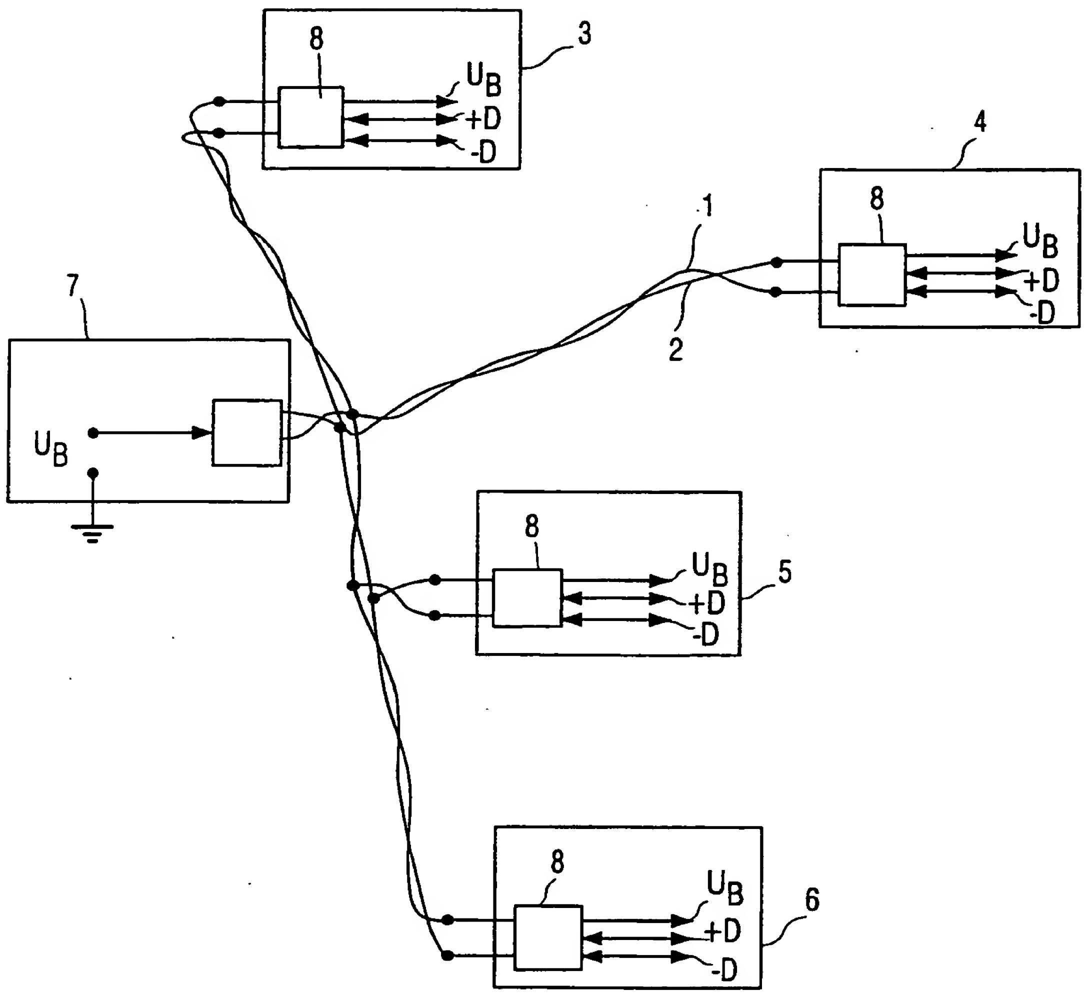

FIG. 1

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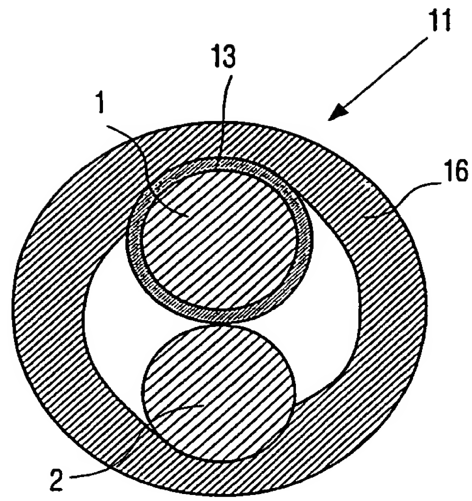

FIG. 2

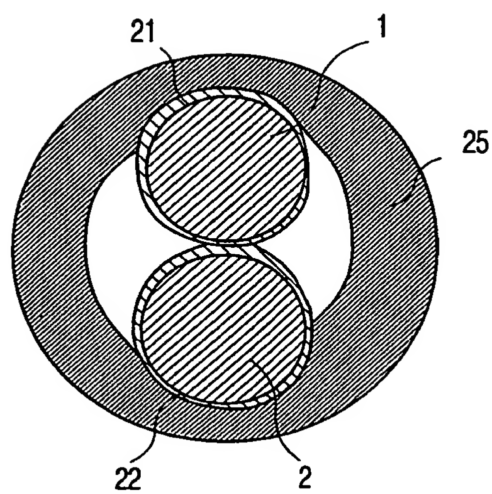

FIG. 3

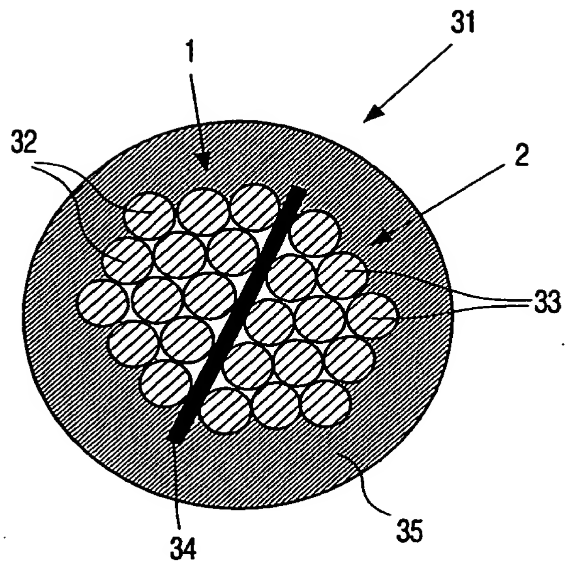

FIG. 4A

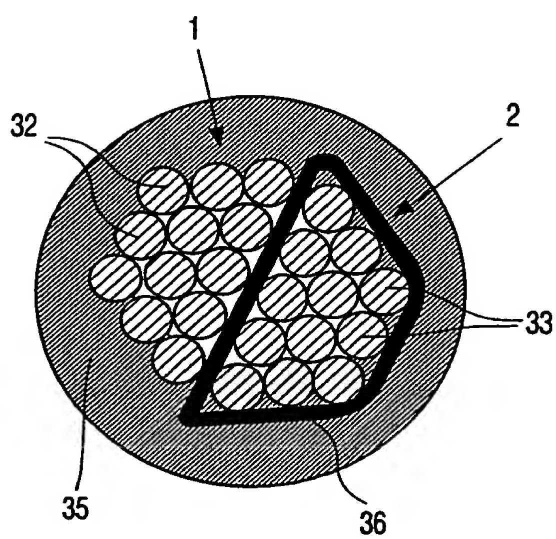

FIG. 4B